Chicago Regional Demonstration Project Report
Presented by HPRC and PLASTICS

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APPENDICES

Executive Summary

The Healthcare Plastics Recycling Council and Plastics Industry Association facilitated a cooperative, first-of-its-kind regional recycling program in the Chicago area and the results of this innovative pilot are in.

With a few exceptions, plastics used in the healthcare industry are single use materials representing a linear “take-make-dispose” economy. In response to current widespread low recycling rates, the Healthcare Plastics Recycling Council (HPRC) and Plastics Industry Association (PLASTICS) asked the question: Is it possible to radically increase the amount of clinical healthcare plastics managed as technical materials in a circular “make-use-return” economy?

To answer this question, HPRC and PLASTICS designed and implemented a multi-hospital plastics recycling project in the Chicago market. Focused on non-infectious plastic packaging and products collected from clinical areas of the hospitals, the project sought to demonstrate a viable business model for the recycling of healthcare plastics on a regional basis.

One of the barriers preventing individual hospital programs from achieving economic viability is that the quantity of materials generated often does not represent sufficient commodity value necessary to attract the attention of recyclers. In bringing together multiple hospitals in the same geographic area, the Chicago regional project hoped to overcome this barrier – to demonstrate that these plastic materials have value, that they can be effectively collected from hospital clinical areas, and that they can be collected in sufficient quantities to surpass the economic tipping point such that recycling of these materials represents a good business opportunity for recyclers.

Participating hospitals collected a variety of healthcare plastics (primarily from main operating rooms and ambulatory surgery centers) which were then transported by waste haulers to material recovery facilities (MRFs) for processing or transferred to specialized plastics recyclers. HPRC and PLASTICS looked to identify key success criteria for a regional cooperative like this, define market requirements, and detail best practices so that the model could be replicated in other geographies and markets.

The project saw success around defining the relative quantities of material types and understanding the complexity of sorting the materials once comingled. As documented in similar studies, sterilization wrap represented the highest volume of material collected, and, as part of this project, the material properties of sterilization wrap were evaluated as a viable substitute or supplement for virgin resins in product manufacturing. Other flexible packaging materials such as film plastics, as well as rigid plastic packaging, were also collected in considerable and consistent quantities.

In addition to exploring mechanical recycling opportunities for these various plastic materials, the team also tested the potential to demonstrate value through energy conversion and chemical recycling. Both trials were successful, suggesting when mechanical recycling options are not available for these healthcare plastics, value can still be realized through other recovery processes.

Overall the project, a first step into exploring the possibilities of regional collaboration, has yielded a number of practical actions that both hospitals and recyclers can take to facilitate increased healthcare plastics recycling.

Acknowledgements

Project Sponsors

The Healthcare Plastics Recycling Council (HPRC) is a private technical coalition of industry peers across healthcare, recycling and waste management industries seeking to improve recyclability of plastic products within healthcare. HPRC is made up of globally recognized members including Baxter, BD, Bemis, Cardinal Health, DuPont, Eastman Chemical Company, Johnson & Johnson, Medtronic and SABIC Innovative Plastics. The council convenes biannually at meetings hosted by an HPRC member that include facility tours to further learning and knowledge sharing opportunities through first-hand demonstration of best practices in sustainable product and packaging design and recycling processes. For more information, visit www.hprc.org.

The Plastics Industry Association (PLASTICS), formerly SPI, is the only organization that supports the entire plastics supply chain, representing nearly one million workers in the $418 billion U.S. industry. Since 1937, PLASTICS has been working to make its members and the industry more globally competitive while advancing recycling and sustainability. To learn more about PLASTICS' education initiatives, industry-leading insights and events, networking opportunities and policy advocacy, and North America's largest plastics trade show, NPE: The Plastics Show, visit plasticsindustry.org. Connect with PLASTICS on Twitter, Facebook and LinkedIn.

Special thanks to the project team and following individuals for countless hours combing through waste:

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Project Participants

Participating hospital networks included Advocate Heath Care and NorthShore University HealthSystem. A total of five hospitals participated in the regional project. Companies providing logistics and recycling solutions included Waste Management, LakeShore Recycling Systems, Antek Madison, RES Polyflow and Resinate Materials Group. Key Green Solutions, LLC, a sustainability management software service provider, collected and maintained project metrics. PLACON provided additional financial support to the project as an interested end-user looking to create new products from the recycled materials. Petoskey Plastics supplied specialized bags for collection and transportation of the plastic materials.

1.0 Introduction

1.1 The Situation with Healthcare Plastics

More than 10 billion pounds of plastic healthcare packaging were placed in the market in 2013.[1] On a global basis, only 14% of plastic packaging is collected for recycling.[2] Across the healthcare sector these rates are significantly lower. As noted in *The New Plastics Economy: Rethinking the future of plastics:* “Today’s plastics economy is highly fragmented. The lack of standards and coordination across the value chain has allowed a proliferation of materials, formats, labelling, collection schemes, and sorting and reprocessing systems, which collectively hamper the development of effective markets” and “The development and introduction of new packaging materials and formats across global supply and distribution chains is happening far faster than and is largely disconnected from the development and deployment of corresponding after-use systems and infrastructure.”

These findings were largely confirmed in a plastics recycling project sponsored by the Healthcare Plastics Recycling Council (HPRC) and the Plastics Industry Association (PLASTICS). With the exception of durable goods and the (currently) limited amount of recycling of plastic products and packaging from clinical settings, plastics used in the healthcare industry are typically single use materials representing a linear “Take-Make-Dispose” economy. In performing this project and other related work, the project sponsors are asking the question: Is it possible to radically increase the amount of clinical healthcare plastics managed as “Technical Materials” in a circular “Make-Use-Return” economy? In contrast to the linear take-make-dispose economy, a circular economy operates on the basis of rethinking the throughput model and asking whether there is a better or more effective way to use the abundance of materials, resources and energy that are squandered in a single use economy. More information on the Circular Economy perspective is provided in section 5.4.

1.2 Project Objective

The objective of the HPRC/PLASTICS Regional Demonstration Project (Demonstration Project) was to demonstrate the economic and operational viability of collecting and recycling clinical plastics from multiple hospitals within the same region. Prior HPRC-sponsored efforts included pilot projects at individual hospitals. One of the barriers which prevented these projects from achieving economic viability was that the quantity of materials generated by a single hospital did not represent sufficient commodity value necessary to attract the attention of recyclers. In bringing together multiple hospitals in the same geographic area, the Demonstration Project sponsors hoped to overcome this barrier to demonstrate that these plastic materials have value, that they can be effectively collected from clinical areas of the hospitals, and that the materials can be collected in sufficient quantities to surpass the economic tipping point such that recycling of these materials represents a good business opportunity for recyclers. In addition, the project sponsors wanted to identify key success criteria, define market requirements, and detail best practices such that the model could be replicated in other geographies and markets.

In operating the Regional Project for much of the second and third quarters of 2016, the project team identified a number of valuable insights into the realities of implementing a healthcare plastics recycling program within hospitals, within a region, and during a time when declining commodity prices limited the economic incentive for plastic recyclers to become involved in unique recycling opportunities. We are pleased to present this report summarizing these efforts, including data collected from materials assessments and feedback from stakeholders at various points in the healthcare plastics value chain.

1.3 Project Overview

Since original project conception in September 2013, the following activities have been completed:

- Evaluation and identification of a target project location, resulting in the selection of the Chicago Metro area.

[1] Plastics for Healthcare Packaging, PLS007E, BCC Research, July 2013
[2] The New Plastics Economy: Rethinking the Future of Plastics; Ellen MacArthur Foundation, 2016

- Stakeholder engagement meeting of regional recyclers and waste haulers to obtain input as to the feasibility of performing this project in the Chicago market.
- Recruitment of hospitals, waste haulers, recyclers, and other stakeholders
- Definition and agreement upon roles and responsibilities of all stakeholders
- Definition and agreement upon acceptable recyclable materials and conditions
- Initiation of recycling activities and/or data collection
- Field assessments of collected recyclables
- Ongoing discussions with hospitals, waste haulers, and recyclers to provide feedback and identify opportunities for improvement.

A detailed project timeline is provided in Appendix A.

2.0 Program Development and Implementation

2.1 Target Materials

It has been estimated that upwards of 1,000,000[i] tons per year of non-infectious plastic packaging and plastic products are available for recovery from clinical settings (procedural areas; generally sterile field set-ups before procedures) within the over 5,000 hospitals located in the continental U.S.[3] The Demonstration Project focused on recycling **clean, non-infectious healthcare plastic** packaging and products collected from the **clinical and patient care areas** of hospitals. Through previous pilot projects performed in individual hospitals HPRC has identified the following as potentially recyclable plastic materials commonly produced in clinical healthcare settings.

Sterilization Wrap: Commonly referred to as "blue wrap", sterilization wrap is a flexible sterile material that protects surgical instruments and other items from contamination. It is often clean following its use and can be collected in significant quantities "pre-case" or before a patient is brought into an operating room for a procedure. It is made from polypropylene (PP) and may be recycled with other #5 plastic materials.

Irrigation Bottles: Irrigation bottles for saline solutions and sterile water are also commonly used in operating rooms. These bottles are easy to drain and collect for recycling. They are most often made from polypropylene (PP), which can be recycled with other #5 materials. Some saline bottles are made from polyethylene terephthalate (PET), which may be recycled with other #1 materials, or high density polyethylene (HDPE), which may be recycled with other #2 materials.

Basins, Pitchers, Trays: Rigid colored and opaque plastic containers such as water pitchers and patient care basins and trays are typically made from polypropylene (PP) and may be recycled with other #5 materials. Rigid colored and opaque plastic packaging trays may also be made from polypropylene (PP, #5), high density polyethylene (HDPE, #2), or polystyrene (PS, #6). Rigid, clear packaging trays used in healthcare are typically made of polyethylene terephthalate glycol (PETG, #7) or polyethylene terephthalate (PET or PETE, #1).

Tyvek®: Tyvek® is a common material utilized in sterile barrier packaging, typically as part of a chevron peel pouch or a lid on a rigid tray. Tyvek® is made from high density polyethylene (HDPE) and may be recycled with other #2 materials.
It can be difficult to visually differentiate Tyvek® from paper. Both have a similar appearance; however, long intertwined fibers can be seen in Tyvek® material when a light source is placed behind the material. Also, paper tears easily while Tyvek® is difficult to tear, although some plastic coated paper is also difficult to tear.

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[3] Practice Greenhealth, https://practicegreenhealth.org/topics/waste; Lee, B., M. Ellenbecker, and R. Moure-Eraso. "Analyses of the Recycling Potential of Medical Plastic Wastes." Waste Management (2002): 461-470

Flexible Clear Film Packaging: Clear film packaging includes shrink wrap, stretch film, thermoform film packaging, and plastic bags and is usually found as secondary and tertiary packaging for healthcare products. Some clear film packaging is made from polyethylene (PE) and may be recycled with #2 materials. Other film packaging is comprised of multi-layer laminates, often including layers of nylon and other materials which are a challenge for most recyclers to manage as component layers are not separable.

2.2 Stakeholder Engagement

Initially, the project team focused efforts on recruiting hospitals to participate in the project. To some extent, the Chicago market was selected based on the density of hospitals located in and around the Illinois Medical District in downtown Chicago; however few of these hospitals were interested in participating in the project primarily due to perceived conflicts with other waste service programs or lack of internal champions willing to take on the challenge of implementing such a program. For these and other reasons, gaining the commitment of hospitals to participate in the project took longer than expected. After considerable effort, the project team identified four hospital networks interested in participating, and ultimately two of these organizations agreed to participate in the program: Advocate Health Care and NorthShore University HealthSystem. All participating hospitals had a process previously in place to capture recyclables from clinical areas of the hospital, including, to varying extents, some of the plastics which were the focus of our study.

Five hospitals participated in the demonstration project. Licensed bed counts of these hospitals ranged from 139 beds to 397 beds with an average of 237 and median of 173. In parallel with recruiting hospitals, the team also solicited the participation of area recyclers. While many recycling companies were interested in learning about the material and the opportunity to work with the healthcare industry, very few companies in the region were positioned to perform the detailed sorting necessary to extract value from a comingled stream of healthcare plastics. Most recyclers are either capable of recycling rigids, or flexibles, but few have the capability to handle both types of materials. Also, during the time when the project team was planning the work, commodity prices for plastic resins experienced a sharp decline as raw material costs plummeted along with the falling price of crude oil. This is discussed in greater detail in section 4.2 of this report. While certain recyclers initially agreed to support the project, the strained market conditions caused some recyclers to reconsider. Antek Madison, a plastic resin distributor and recycler with processing and warehouse locations in Chicago and Toronto, agreed to support the project, along with a few other recyclers or reclaimers in the region.

2.3 Logistical Challenges

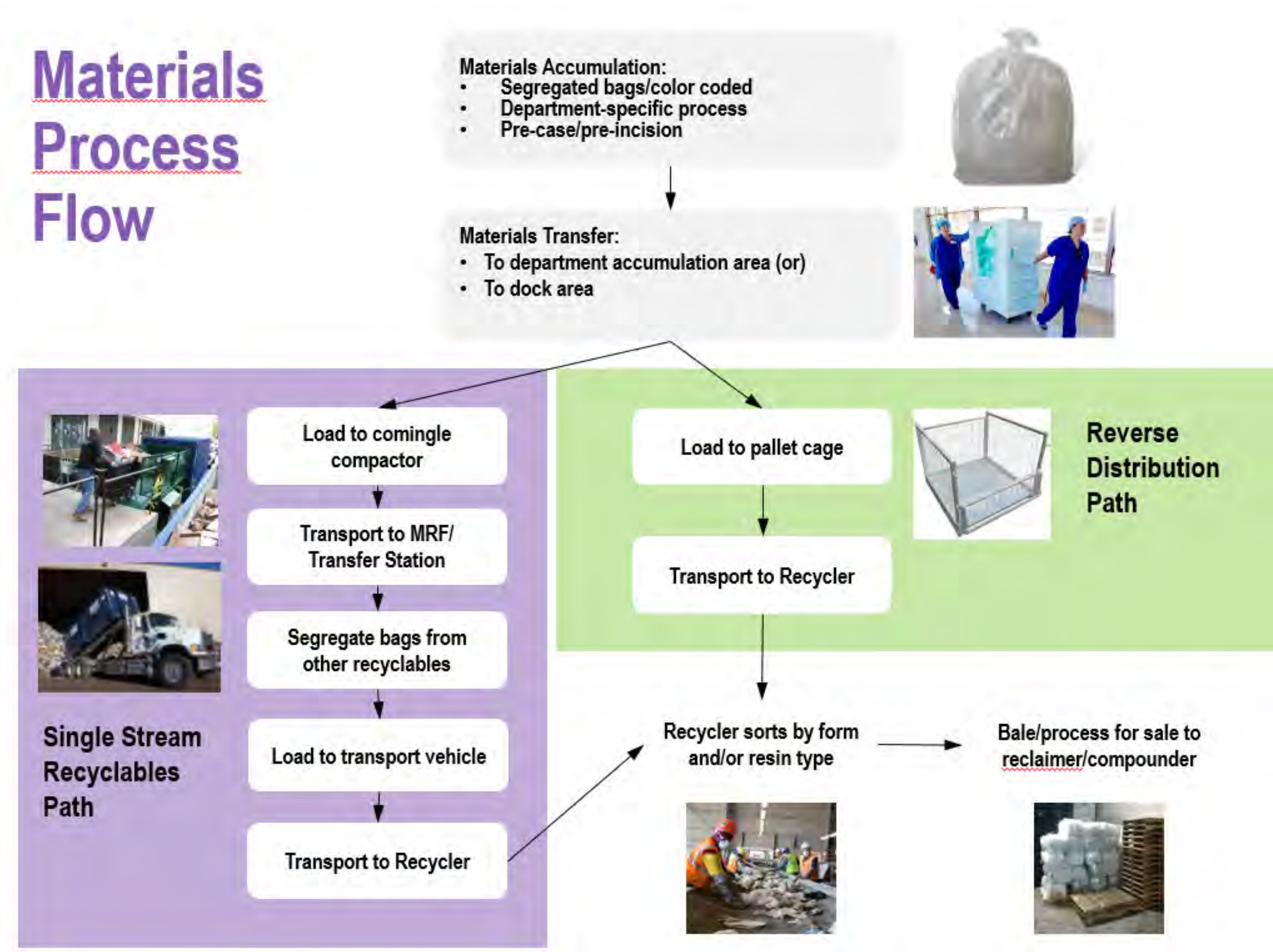
As observed in previous HPRC studies, some of the greatest challenges with recycling healthcare plastics is the sorting that is required to extract maximum value from the collected materials and the logistics of transporting the accumulated materials from the hospital to the recycler. For the Chicago project, the following logistical challenges were identified:

- Limited space in the clinical areas that prevents clinical staff from performing separation of materials by form or resin type at the source of generation.
- Limited space in the loading dock areas at the hospitals, preventing placement of dedicated containers for target material accumulation.
- Additional labor requirements for material handlers within the hospitals (usually Environmental Services – EVS – staff) to transfer the bags of target materials to special accumulation areas.
- Based on current economic conditions, the value of the materials was not sufficient to offset the costs for the recyclers to provide dedicated accumulation containers and ship the materials from the hospitals to the recycler facilities.

To overcome these challenges, the project team identified two potential pathways for conveying the materials from the hospitals to the recyclers:

- Single Stream Recycling: Target materials are conveyed to a recycler using existing recycling systems that are already in place for collection, accumulation, and transportation of cardboard, ledger paper, cans and bottles.
- Reverse Distribution: Target materials are channeled from the hospital to the recycler via existing transportation schemes already making deliveries (i.e. medical supply vendor) or pickups of other waste or recyclables at the hospital (i.e. Regulated Medical Waste service provider or document destruction company service providers).

Figure 1: Pathways for Transfer of Materials from Hospital to Recycler
A larger image is provided in Appendix B.



The Single Stream Recycling Pathway required the use of bags which could be used to differentiate the target materials from other recyclables in the single stream loads. Petoskey Plastics generously agreed to donate a supply of bags to the program equivalent to the number of bags the project team expected each hospital to use during the initial three months of program operation.

The primary benefit of using a reverse distribution model is that materials are handled separately from solid waste and other recyclables, reducing the potential for contamination from these materials. Also, the target materials may be shipped directly to a recycler without the need to separate the materials from other recyclables or solid waste. A drawback of using a reverse distribution approach is that separate handling and accumulation within the hospital may add to labor costs. There is also the possibility that the reverse distribution transporter may levy a separate transportation charge for shipment of the target materials to the recycling facility.

Considering existing resources and processes, moving the target materials along with the hospital's single stream recycling may be the most cost effective solution for a number of reasons. Assuming a single stream recycling program is already in place at the hospital and supported by the hospital's waste hauler, clinical plastics may be transferred within the hospital, accumulated and transported to the waste hauler's material recovery facility (MRF) using equipment, labor, and processes that are already in place, thereby avoiding separate handling costs and transportation charges. This also eliminates the environmental impacts of having a separate pickup of materials at the hospitals. Critical to this approach is the use of color-coded bags, labels, or ties that will enable handlers to quickly segregate plastics from clinical areas from the rest of the recyclables generated in the hospitals.

The primary drawbacks of using the single stream pathway include: an increased chance of contamination from other recyclables in the shipping container (typically a compactor where bags of recyclables are often ruptured in the compaction process), and bags of target materials must be separated from other recyclables at the MRF or recycling facility for accumulation and transfer to the plastics recycler (unless the MRF is capable of sorting and processing the healthcare plastics). Sorting, accumulation, and transfer of materials to the plastics recycler may also incur additional charges from the waste hauler for special handling.

For the Demonstration Project, the single stream pathway was the most practical method of transferring the materials within the participating hospitals (using the same carts EVS staff used for transfer of solid waste and other recyclables) as well as transporting the materials from the hospital to the MRF or high-grade recycling facility in the single stream compactor. Single stream recycling programs were already established at all of the hospitals participating in the project and each hospital was already using the single stream pathway for recycling of varying types of materials from clinical areas. Both LRS and WM were instrumental in arranging target material accumulation and allowing the project team to visit their facilities to perform detailed materials assessments.

2.4 Program Implementation

Once all of the key stakeholders were in agreement on the project, the project team worked with the recyclers and waste haulers to define which materials were acceptable for recycling based on the capabilities and acceptance criteria of the MRF or recycler processing the materials (see Table 1 below). Internal champions were identified within the hospitals and staff training sessions were planned and implemented. HPRC provided poster and training presentation templates which the hospitals could use to develop their internal training materials. These and other resources are available through HospiCycle, a recycling resource for hospitals available through the HPRC website (http://www.hprc.org/hospicycle). A sample poster used in the clinical settings can be found in Appendix C.

Material assessments were a key part of the program to determine effectiveness of collection and accumulation processes and to collect data on recyclables. Data collection on materials collected from clinical areas of the hospitals was initiated in March of 2016 and the project team conducted a number of assessments of materials accumulated at MRFs and recycling facilities between April and September 2016. Details on the findings of these assessments are included in Part 3.0 of this report.

2.5 Recycling Activity Overview

Participating hospitals collected a variety of healthcare plastics, primarily from the hospitals' main operating rooms and ambulatory surgery centers. Due to varying capabilities and acceptance criteria of the waste haulers/recyclers for the hospitals, there was some variation in the materials collected for recycling, as shown in the following table.

Table 1: Recycling Facility Materials Acceptance

Waste Hauler	Recycler	Form (Type) of Materials Recycled
Waste Management	Antek Madison	• Blue/Sterilization Wrap (polypropylene - PP/#5) • Trays/Pitchers/Bowls (PP/# 5) • Rigid Instrument Packaging - Opaque (high density polyethylene - HDPE /#2, PP/#5, polystyrene - PS/#6) • Rigid Instrument Packaging – Clear (polyethylene terephthalate - PET#1 or PETG#7) • Saline Bottles (PP/#5) • Wipes Containers (HDPE/#2) • Tyvek® tray lids (HDPE/#2)
Lakeshore Recycling Systems	LRS Heartland (MRF)	All above materials plus: • Film Packaging (HDPE/#2, Low Density Polyethylene – LDPE/#4, laminated film, and formed film/cavity bags), • Empty Surgical Tubing and IV Bags (Polyvinyl Chloride – PVC/#3) • Recyclable paper and glass.

3.0 Material Assessment

3.1 Assessment of Materials Accumulated at MRFs

Following the implementation of materials shipment and tracking through the recycling facilities, four materials assessments were conducted during which the project team visited the Waste Management (WM) MRF and the Lakeshore Recycling System (LRS) MRF to perform detailed assessments of materials accumulated from multiple hospital shipments. These were completed on April 13, April 14, June 8 and June 9, 2016. In addition, the team also performed a separate assessment of materials generated exclusively during surgical procedure setups, or "pre-case" materials, on September 7, 8, and 9, 2016. The following table provides a summary of the information obtained during these assessments regarding the composition of the materials collected. The following table provides a summary of the information obtained during these assessments.

Table 1: Material Assessment Composition Data

Material Type	WM MRF Assessment	LRS MRF Assessment	Pre-case Assessment	HPRC Stanford (2013)
Blue Wrap	47%	17%	37%	36%
Paper	Not Accepted, Included in "Other"	15%	16%	22%
Rigid Plastics	13%	12%	11%	19%
Other Flexibles (Non-Woven and Film Plastics)	Not Accepted, Included in "Other"	22%	26%	21%
Other Recyclables and Waste	40%	33%	10%	2%
Rigid Plastics Breakdown				
Opaque Rigid Plastics	7%	10%	6%	N/A
Rigid Blue Tint PETG/#7 Packaging	6%	2%	2.5%	N/A
PP/#5 Bottles	Included with Opaque Rigid	Included with Opaque Rigid	2.5%	N/A

As noted in other studies, and inherent to waste generated in clinical areas of hospitals, blue wrap (or sterilization wrap) is the material most recognizable and most often targeted for recovery in clinical recycling programs. As confirmed by our assessments, blue wrap is also the highest (or one of the highest) volume recyclable materials generated in these settings. This material consists of readily-recyclable, high quality polypropylene (PP), which is a #5 plastic according to the Resin Identification Coding (RIC) system. A detailed assessment of blue wrap's material properties is included in Appendix D, as performed by The Lavergne Group in their evaluation of the material as a substitute or supplement for virgin resins in product manufacturing.

Also present in significant quantities are other flexible plastics, most of which are single-use packaging materials made of clear film materials. Rigid plastics such as irrigation bottles, basins, pitchers and trays represent a smaller but still significant amount of collected materials.

Not surprisingly, the proportions of plastic and paper materials measured during the pre-case and MRF assessments are comparable to those observed in the HPRC-sponsored Stanford Study performed in 2013. While there are many factors affecting material collection and generation rates, these numbers suggest that some continuity exists within the healthcare industry regarding the nature of recyclable materials generated in operating rooms and other clinical areas of the hospitals, and provides further validation of the detailed assessment performed by the Stanford project team. Note, the material represented in the "Other Recyclables and Waste" category for Stanford is strictly metallic foil.

In comparing the assessments of materials accumulated at the Chicago MRFs, it is important to note the difference in acceptance criteria between the hospital's recycling programs, namely that paper and non-blue wrap flexibles (primarily film plastic packaging) were not accepted for recycling in the materials collected for transfer by WM to Antek Madison.

3.2 Assessment of Hospital Pre-Case Materials

In performing audits of target materials accumulated at the MRFs, the project team encountered significant levels of solid waste contamination (typically personal protective equipment and cleaning materials) intermixed with the healthcare plastics. The project team believed that this contamination could be minimized if the hospitals were to restrict materials collection to the time during which the OR (or other procedural area) is being set up for a procedure, or "pre-case", since it is at this time that instruments are unwrapped and removed from packaging. One measure to control for contamination could be to tie off and remove the bag from the OR prior to the patient entering the room. To test this strategy one of the participating hospitals agreed to let the project team perform an assessment of pre-case materials generated during setup of ORs for various types of inpatient and outpatient surgical procedures.

Based on the assumption that nearly all of the materials generated on a pre-case basis are potentially recyclable (including paper and foil in addition to plastic packaging), the project team requested that the clinicians collect all materials generated during procedure setup, including plastic and non-plastic materials. One of the objectives of this assessment was to get an understanding of what portion of the total pre-case material is plastic, and to determine the form and composition of the pre-case plastic materials in comparison to the types of plastic materials generated before, during, and after procedures. Results of the pre-case assessment are included in Table 2 above.

Believing that the majority of the materials generated pre-case were plastic packaging, the project team also wanted to collect a sample of pre-case materials for assessment of acceptability as feedstock for pyrolysis conversion of plastics to liquid fuel by RES Polyflow. More information on this option can be found in section 3.4.

3.3 Assessment Quantities and Projections of Annual Recycling Rates

The following table summarizes the quantities of materials assessed during this project and provides projections of healthcare plastic recycling rates based on the amounts of materials observed during the assessments.

Table 3: Assessment Quantities and Projected Clinical Plastic Recycling Rates

Assessment Quantities	WM MRF Assessment	LRS MRF Assessment	Pre-case Assessment
Number of Bags/Procedures Audited	89	55	37
Total Weight of Material Audited (lbs.)	187	237	105
Weight/Bag (Procedure)	2.1	4.3	2.8
Average Weight of Recyclable Plastics/Bag (Procedure)	1.3	2.2***	2.1
Average Number of Bags/Shipment	22.3	27.5	
Number of Shipments Per Year (Estimated)	52**	130**	
Quantity Projections			
Est. Number of Inpatient and Outpatient Surgeries			12,380*
Licensed beds represented	397	789	397
Projected Clinical Plastic Recycling Rate (lbs/year)	1,462	7,857	26,000
Estimated annual clinical plastic recycling per bed	3.7	10	65.5

** Estimated number of inpatient and outpatient surgical procedures performed annually is based on the number of procedures performed in 2015 and the number of procedures performed from January through October 2016.*
*** Estimated quantity based on number of shipments observed during project term.*
**** The difference in weight of recyclable plastics per bag (between WM and LRS MRF assessments) is primarily attributable to the difference in material acceptance between LRS and WM, namely that LRS accepted flexible plastics and PVC during the project.*

Generally, for the hospitals that participated in our project, there was one bag of clinical recyclable materials produced for each operating room procedure. To produce the annual projections in the first two columns of this table, the project team applied the average percentage of potentially recyclable plastics present in each bag (based on percentages presented in Table 2) to the average total weight of each bag of clinical recyclable materials to determine the average weight of the healthcare plastics in each bag. This amount was multiplied by the average number of bags per shipment and the estimated number of shipments made each year from the hospital or hospital group to determine the projected annual clinical plastic recycling rates.

Considering the pre-case assessment results, clinical recyclable materials were collected from inpatient and outpatient surgical procedures, and the materials assessment was performed in the hospital to determine the average amount of recyclable plastic produced during procedure setup. This amount was multiplied by the average number of inpatient and outpatient procedures performed each year to determine the potential annual plastic recycling rate based on collection of all pre-case materials. In comparing this projection with the projection based on the amount of material received at the MRFs, it is clear that only a fraction of the total amount of potentially recyclable plastic materials were being diverted from the solid waste stream for recycling during the demonstration project.

3.4 Chemical Recycling

In addition to exploring mechanical recycling opportunities for these various plastic materials, the team also tested the potential to demonstrate value through energy conversion and chemical recycling. The team partnered with RES Polyflow to process a sample of healthcare plastics in their pyrolysis system, which converts plastics into liquid fuel products. The team also sent PETG packaging trays to Resinate Materials Group for chemical recycling, where the PETG was converted to polyols for use in foams, coatings and adhesives. Both trials were successful, suggesting when mechanical recycling options are not available for these healthcare plastics, value can still be realized through other recovery processes.

4.0 Stakeholder Feedback

4.1 Hospital Feedback

Hospital experiences varied based on the sorting criteria and requirements of their partner waste hauler and recyclers. Where significant sorting of materials was required in the clinical setting, the following feedback was provided.

The hospital's internal champions went out of their way to obtain buy in from management, EVS, and clinicians before committing to the project, realizing that everyone must be onboard with the decision. Management agreed to participate with the caveat that there are other priorities, and the project must have minimal impact on the work of others. The internal champions made significant efforts to train staff and reinforce the training with posters, presentations, quizzes, and just-in-time coaching.

Upon implementing the program, they found the process to be much more difficult than anticipated. The complexity of having to identify which materials were acceptable for recycling, sort those out and place only those items in the designated bag proved to be a significant behavioral change for clinicians and a difficult proposition considering other primary clinician priorities, resulting in collection of significantly less material than expected. In section 4.3, we provide some additional information about the behavioral aspects of recycling.

Following are some specific points mentioned during the interview of one of the clinical champions:

- The marked bags used for accumulation of the target materials looked similar to the bags the hospital used for solid waste, causing many bags of target materials to end up erroneously in the trash compactor.
- Blue wrap was the easiest material to collect because it is high volume and clinicians know exactly what it was.
- Saline bottles also had a good chance of being collected since it mimics residential recycling items (plastic bottles).
- Tyvek was found to be most difficult to collect because it mimics paper and clinicians had to fully separate a Tyvek lid from the bottom container to meet the recycler's acceptance criteria.

The hospital's key takeaway was that an effective clinical recycling program must 1) be simple for clinicians to follow and 2) reduce the sorting burden at the point of collection. Examples include collection of all pre-case materials in the same bag for sorting by a third party (if required), or collection of a very limited, defined set of items for recycling (one or two material types). Near term, the hospital is actively exploring blue wrap recycling options.

4.2 Recycler Feedback

WM-RSI: WM-RSI is a high grade recycling facility handling a broad range of recyclable materials. Considering the clinical plastic materials received at WM-RSI for accumulation and transfer to Antek Madison, the management team recognized blue wrap as having the highest potential value of all materials collected. They witnessed first-hand the presence of contamination in the bags of materials they received from the hospital and understood the need to eliminate this to preserve material value. Also, the quantities of materials they received did not represent sufficient economic value necessary to offset costs of handling and storing the materials. When considering handling options, processing the materials utilizing their automated sorting systems (comparable to those utilized in MRFs set up for management of commercial and residential recycling) was not an option due to the presence of significant quantities of flexible plastic materials in the shipments which fouls mechanical components.

In retrospect the WM team realized the need to have much greater involvement in setting up the program within the hospital for the program to be successful so as to understand all of the intricacies of making the program work, and working closely with hospital program champions who they recognized as critical to program success. Considering the (currently) limited value of the materials they would need to charge customers an additional fee to set up and maintain such a service.

Antek Madison: Antek Madison is a plastic resin distributor and recycler with processing and warehouse locations in Chicago and Toronto. The target materials shipped to the Antek Madison facility in Chicago were initially accumulated at the WM-RSI high grade recycling facility. While the target materials were screened at WM-RSI to remove contaminants, the variety of plastic materials present in the comingled stream was problematic, and sorting by plastic type was a much more significant undertaking than anticipated when Antek Madison initially agreed to participate in the project. In addition, material handlers remained concerned that the materials were potentially infectious based on the source. Considering the range of materials and quantities included in the comingled stream, Antek Madison recognized that blue wrap was the easiest material to sort and process.

In their assessment Antek Madison pointed out that there were "…a multitude of items in this (comingled) feed stream. We tried to sort materials by their plastic type but the process to sort is/was time consuming and daunting." While automated equipment exists to clean and process this type of comingled material, the cost to purchase and install this equipment is prohibitive. Considering current crude oil prices, the resin market is depressed and, "As long as plastic values are low, we do not see a financial incentive to process this type of scrap."

Resinate Materials Group®: Resinate Materials Group (Resinate), a specialty chemicals manufacturer located in Plymouth, MI, manufactures polyester polyols which are chemical intermediates used in the production of specialty applications such as coatings, adhesives, sealants, elastomers, and foam. Resinate's materials are primarily derived from recycled and renewable feedstocks, with most products containing up to 100% green content.

One of Resinate's primary feedstocks is recycled PET (Polyethylene terephthalate) using both post-industrial and post-consumer PET sources. As indicated, a common single-use packaging material used for healthcare products and equipment is Polyethylene terephthalate glycol-modified (PETG) which currently has no viable recycling options and therefore ends up in landfills rather than being recycled and reused. At the request of the project team, Resinate performed a laboratory evaluation of a grab sample of PETG packaging material to determine the applicability and suitability of PETG as a potential future feedstock for their polyol technology.

After completing their in-house evaluation and testing with lab-scale quantities, the performance of the medical PETG material when used as a feedstock in developing polyester polyol resulted in product characteristics which appear to offer improved weathering resistance when compared to characteristics of a recycled PET based polyester polyol. This experiment provided compelling economic and practical reasons to work for recycling this valuable raw material into specialty applications such as coatings, a solution that will help avoid landfill as an option for this valuable raw material.

RES Polyflow LLC: RES Polyflow makes energy products from difficult to recycle polymer and rubber waste that is destined for landfills or incineration. Their proprietary equipment converts mixed polymer waste into fuels and petrochemicals without excessive handling, sorting or cleaning. They are interested in providing a viable solution for waste to value opportunities where co-mingled scrap streams previously deemed has having poor economic value (like the healthcare plastics target materials) can be re-characterized as creating and holding value for a technology such as plastics to fuel.

To test this alternative, the project team provided a sample of pre-case materials as collected in the clinical areas without performing any sorting prior to screening by RES Polyflow. The objective was to determine if these comingled materials would provide acceptable feedstock "as generated" in these settings with the only concern being to minimize the potential for contamination with hazardous materials by restricting collection to pre-case situations. As indicated above, these materials are composed primarily of single use film and rigid packaging. Results were as follows:

- A high amount of fiber was present in the form of paper, packaging cartons, and misc. fiber with the sample estimated to contain 20% fiber by weight; which is an extraordinary amount of contamination that must be removed (preferably at the source) if the material is to be managed by RES Polyflow in an ongoing manner.

- Once the fiber was identified and removed the remaining plastic was loaded into the converter on a co-mingled basis. RES Polyflow does not sort the plastic by resin type unless there is an obvious item such as a large piece of polyvinyl chloride (PVC, #4) that is easily detected. PVC is not a suitable feedstock for a plastics-to-fuel conversion operation due to the high level of chlorine present in the material.

- Other non-polymer contaminants present in the sample were cloth textiles and a small amount of metals (foil).

Results: RES Polyflow ran a two pound sample of co-mingled plastic that was pulled randomly from the material provided. The plastic processed did not present any difficulty in the operation of the conversion process, it made good liquid hydrocarbon and was easy to manage. The co-mingled plastic waste generated in a pre-case (non-pathogenic) environment is suitable for energy recovery via plastic-to-fuel. There is however a need to keep fiber, paper, PVC, and textiles out of the plastic during collection.

Lavergne: Over the course of project implementation the project sponsors identified the technology company HP as a potential end-user of recycled polypropylene resin derived from blue wrap. To determine material acceptance, the project sponsors made arrangements for a sample shipment of this material to The Lavergne Group, a designer of sustainable engineering resins which was performing materials research on behalf of HP. Lavergne's technical assessment of the blue wrap material is included in Appendix D.

Generally, the properties of the polypropylene resin produced from blue wrap are favorable for recyclers and compounders of these resins in that the material has a high melt flow rate which allows recyclers to raise the melt flow of lower melt materials which are more prevalent in the market. In the hospital the material is typically secured with a paper backed tape which can be problematic for processing, however this challenge may be overcome with certain continuous melt filtration systems which are becoming more common in the industry. Maximizing the value of blue wrap for compounders requires accumulation of significant quantities, ideally compressed into 1,000 lb. bales with shipments of 40,000 pounds.

5.0 Project Learnings

5.1 Key Insights

Some of the insights and learnings from the project include:

- Keep it simple: As noted in interviews of hospital representatives, collection of clinical plastics must be simple for clinical staff participation. In retrospect, the project team suggests starting with one commodity to initiate the recycling channel, demonstrate success in diverting a clean stream of materials from the solid waste stream, and gradually add additional types of plastic material to the program over time. Besides simplicity in material collection, there must be clear handling methods for accumulated materials. Once recovered, the accumulated materials must be clearly distinguishable from other types of waste and recyclables, and handling practices of accumulated materials (i.e. bags) must be simplified as much as possible to ensure that materials are delivered to proper containers or processing areas.
- Champions are critical: Critical to program success is the engagement and commitment of program champions within each stakeholder group who can assist with training, audits, and reinforce the behaviors necessary to ensure effective material collection. All stakeholders must see tangible benefits from participation, and benefits must outweigh the costs of both starting and maintaining the program. All stakeholders need to be fully committed and have champions at each level. Participating hospitals had strong program champions in both the clinical and support areas of their organizations.
- Behavioral change is a process: Recycling within the hospital entails behavioral change for the clinical staff. Behavioral change can be a slow process that requires consistent reinforcement of the desired behaviors. Change can be difficult, and reminding all stakeholders of the social and environmental benefits of recycling and showcasing successes, even small ones, helps everyone remember the original purpose for the change. This is discussed in greater detail in section 5.3 below.
- Comingled materials have marginal value: Ideally, the hospital will create a partnership with a recycler/processor that is flexible and willing to modify current practices to access a new source of recyclable materials. All parties need to recognize that, in comingled form the clinical plastics have limited value, and extracting value from the individual components requires detailed sorting by plastic resin type. Who will be responsible for this sorting? Most hospitals or healthcare networks will not take on this responsibility (reference first bullet), hence the need to identify a recycling partner capable of performing the sorting (manually or through automated systems), or focus hospital accumulation efforts on a single type of material (such as blue wrap) and consider adding other types of materials (accumulated separately) once systems are established.

- **Reduce the variety and complexity of plastic materials used in healthcare:** Hospitals and manufactures should partner to streamline the types of plastics entering the healthcare market so less detailed sorting is required for recycling these materials. Considering the challenges experienced in sorting the clinical plastic materials – both in the hospitals and the recycling facilities – there is an opportunity to greatly increase recycling rates by limiting the range of plastic material types and minimizing material combinations which effectively preclude recycling through existing channels.
- **The economics must be favorable to recyclers:** To attract the attention of recyclers and their customers (plastic material compounders or end-user manufacturers) the plastic materials must be available in sufficient volume, and processes must be in place to ensure that they will receive a clean, continuous supply. This is necessary for securing the end users' commitment to incorporate the recycled materials into their products, thereby providing a demand for the materials necessary to keep the program running. As noted in the follow section, a recycling program's economic viability is a function of market pricing. Stakeholders must think through the economic "tipping point" and consider market volatility when evaluating the financial costs of collecting, aggregating, transporting, processing and marketing materials from a clinical source. Ultimately the economics of a project must be favorable to all parties if the program is to be sustainable, and including certain types of materials may not be possible based on recycled commodity value.
- **Clinical plastics recycling supports broader sustainability initiatives:** Beyond immediate economic benefits, organizations in a variety of industries have set and achieved goals to radically reduce the amount of solid waste they send to landfills or solid waste incinerators. Typically these programs start with a pragmatic look at the composition of their solid waste stream and identification of which materials may be reused, reduced, or recycled; and plastics are always part of the mix. The benefits of these programs can include enhanced employee engagement, greening of the supply chain, and reduction in the organization's carbon footprint. Considering many organizations' broader sustainability goals, these benefits may greatly outweigh economic considerations.

5.2 Challenges Identified

Some of the challenges experienced over the course of the project were external to the efforts of Chicago-based stakeholders.

Market Pricing: The market pricing for commodities derived from recycled materials is strongly influenced by the market pricing of comparable virgin materials, which in this case is strongly influenced by the price of crude oil and natural gas. The significant decline in the price of crude oil and natural gas which began in Q3 2014 and continued into 2015, resulted in a corresponding decline in the prices of most plastic resin commodities during the same time frame (see figures below).

Considering the reduction in commodity values, it becomes more challenging for recyclers to justify handling costs such as those required to manually sort a highly varied mixture of materials (like the comingled healthcare plastics stream) if these materials cannot be sorted using an automated system.

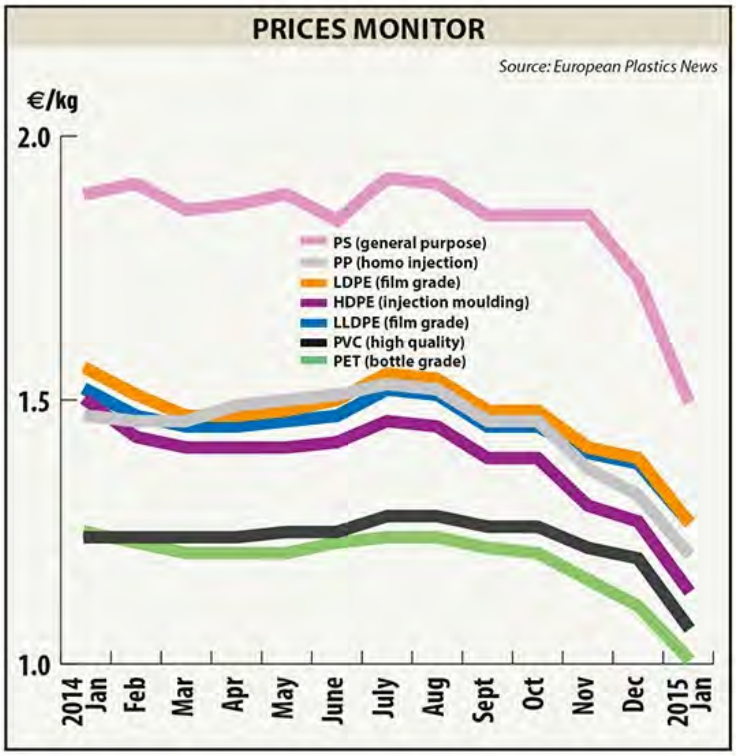


Figure 2: Polymer Prices Drop as Oil and Feedstock Costs Fall (ref. Plastics News Europe, 3 February 2015)

Figure 3: Recycling Becomes a Tougher Sell as Oil Prices Drop (ref. Wall Street Journal 5 April 2015)

Operation Green Fence: Initiated in 2013, China's Operation Green Fence[4] had a significant impact on export markets for marginally valuable commodities such as mixed plastics, effectively removing an export option for any lower grade or comingled plastic materials, particularly films.

Addressing polymers and additive composition: Any variation from basic resin types adds complexity to recycling, necessitating testing to determine properties of resulting products. As with the packaging used in many industries, it is common to find packaging in clinical healthcare settings composed of multiple material types that are laminated or in assemblies which are difficult (or impossible) to disassemble. It is impractical to think that recyclers, most of which are local or regional operations, would do testing of this type of packaging to define properties and identify end-user markets for these materials. In reviewing samples of target materials with Antek Madison prior to project implementation, they determined that they would not be able to accept the flexible film packaging materials due to the frequency in which these materials were composed of multi-component laminates. From a circular economy standpoint, the difficulty of recycling these laminated packaging materials limits options beyond a single-use, representing a linear "Take-Make-Dispose" economy, whereas packaging comprised of basic resin types which are easy to process and easy to identify are more likely suitable for a circular "Make-Use-Return" economy. For further consideration of the circular economy concepts please see section 5.4 below.

5.3 Behavioral Aspects of Recycling

Changing behaviors in the hospital to effectively divert materials from the solid waste stream, while minimizing contamination, presented a significant challenge to program success – more significant than the program champions within the hospitals anticipated. While holding training sessions for all participants, providing in-service instruction, and providing feedback on performance, program champions experienced difficulty getting participants to consistently identify, separate, and place target materials in designated receptacles.

To begin recycling in a setting where there was previously no recycling (or perhaps only limited recycling) requires a change in behavior. Changing behavior requires a change in priorities which may not be feasible in some situations depending on:

- **Resources:** There are only so many hours in a day and only so many hands for the manual work of sorting and handling materials. If existing resources are maximized and there are no opportunities to add FTEs, an organization may not be positioned to add recycling programs in clinical areas.
- **Priorities:** Clinicians view their primary responsibility as ensuring positive patient outcomes. Recycling program champions need to recognize that asking clinicians to perform detailed sorting of waste materials is far from their primary priorities.
- **Culture:** As recognized through academic studies, people's environmental awareness and therefore propensity to participate in recycling programs varies throughout our society.[5] When programs are voluntary, organizations will have varying degrees of participation amongst their staff, and varying results when trying to influence people to produce a clean stream of recyclable healthcare plastics.

Some tools to consider:

- **Drive recycling into operations:** Make recycling a requirement with top-down reinforcement of the importance of recycling to the organization.
- **Create uniform commitment:** Make individual and department commitments public knowledge by turning signing ceremonies into publicized events.
- **Implement 5S tools:** "Lean" business management tools are often credited as a means of changing the culture of an organization. See Appendix E for more information.
- **Engage "change management" resources[6]:** These resources specialize in behavioral and process change and may be available through human resource departments.

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4 http://www.waste360.com/business/what-operation-green-fence-has-meant-recycling

5 http://www.sciencedirect.com/science/article/pii/S2214804315000075; http://www.pollutionissues.com/Pl-Re/Popular-Culture.html

6 Many of these programs are based on the popular book "Our Iceberg is Melting" by John Kotter: https://www.kotterinternational.com/book/our-iceberg-is-melting/

5.4 Circular Economy and Sustainable Materials Management Perspective[7]

With the exception of durable goods and the (currently) limited amount of recycling of plastic products and packaging from clinical settings, plastics used in healthcare are typically single use materials representing a linear "Take-Make-Dispose" economy. In performing this project and other related work the project sponsors are asking the question: Is it possible to radically increase the amount of healthcare plastics managed as "Technical Materials" in a circular "Make-Use-Return" economy?

In contrast to the linear take-make-dispose economy, a circular economy operates on the basis of rethinking the throughput model and asking whether there is a better or more effective way to use the abundance of materials, resources and energy that are squandered in a single use economy. Following are some general statements regarding the plastics economy as taken from The New Plastics Economy: Rethinking the Future of Plastics; Ellen MacArthur Foundation, 2016:

- Looking at the entire plastics economy, after a short first-use cycle, 95% of plastic packaging material value, or USD 80–120 billion annually, is lost to the economy.
- Globally only 14% of plastic packaging is collected for recycling. When additional value losses in sorting and reprocessing are factored in, only 5% of material value is retained for a subsequent use. With few exceptions, plastics that do get recycled are mostly recycled into lower value applications that are not again recyclable after use. The recycling rate for plastics in general is even lower than for plastic packaging, and both are far below the global recycling rates for paper (58%) and iron and steel (70–90%).

A Circular Economy diagram is provided in Appendix F.

5.5 Present Situation and Next Steps

Hospitals

Considering the variety of materials encountered in the clinical setting, contamination of recycling streams with other non-infectious plastics, paper, and waste, identified in this study from 25-45%, will continue to be a significant challenge moving forward. Since opportunities for recycling all plastics in a co-mingled fashion are limited at this time (a finding of this study), some hospitals are considering other approaches, such as limiting the types of materials collected for recycling (with probable focus on sterilization wrap), re-use solutions such as donation of select materials to local non-profit organizations, or pursuing pre-case collection of plastics for use in energy recovery for plastic-to-fuel solutions.

Waste Haulers

- Waste Management (WM): Considering the amount of contamination in the program materials WM accumulated at their RSI high grade facility, it was necessary for project team members to screen the materials prior to transfer of the materials to Antek Madison. This is not a sustainable arrangement and caused WM to utilize valuable space at their facility to temporarily store the materials between project team's screening events. The project team appreciates Waste Management's commitment to recycling and their support of the project team's efforts.

- Lakeshore Recycling Systems (LRS): Since installing highly automated waste sorting equipment at their Heartland MRF in early 2016, LRS has transitioned away from the manual process previously used which allowed them to perform detailed sorting of the clinical materials they received. As of this writing, LRS is working to identify an area plastics recycler who will accept the comingled clinical materials they receive from hospitals in the single stream loads.

Recyclers

As noted in section 3.4, certain types of plastics commonly found in clinical settings can be profitably recycled including sterilization wrap (PP, #5), polyethylene terephthalate glycol-modified packaging trays (PETG, #1), and possibly other types of

[7] Reference: The New Plastics Economy: Rethinking the future of plastics; Ellen MacArthur Foundation, 2016

flexible and rigid materials identified in section 2.2. Considering the diversity of material types used for manufacturing of supplies and packaging used in clinical settings, once healthcare plastics are comingled it becomes challenging for recyclers to expend the labor or other resources necessary to separate the materials by resin type – a necessary step for recycling (or in circular economy terms, return of the materials for reuse as a technical nutrient). As an alternative, the comingled healthcare plastics appear to be acceptable feedstock for conversion to a liquid fuel for energy recovery.

As stated in the introduction, the objective of the HPRC/PLASTICS Regional Demonstration Project (Demonstration Project) was to demonstrate the economic and operational viability of collecting and recycling clinical plastics from multiple hospitals within the same region. While market conditions precluded the project team and stakeholders of accomplishing some of the project objectives, the sponsors hope the information included in this report will provide useful insights which hospital networks and regional healthcare organizations may use to implement regional healthcare plastics recycling programs.

For more information on this project and report, please contact Chris Rogers at chris.rogers@anteagroup.com or visit www.hprc.org.

Appendix A – Project Timeline

Chicago Project Timeline

HPRC Healthcare Plastics Recycling Council

2013

September 2013
Concept of regional pilot first discussed during HPRC meeting

2014

May 2014
Submittal to 2014 Recycling Innovators Forum outlining opportunity and project concept

July 2014
Work plan drafted. Begin evaluating cities for the project based on HFAB locations.

August 2014
August 26-27: Work planning session in Chicago.

September 2014
1st place winner of Recycling Innovators Forum Award - $20,000

October 2014
SPI introduced as partner. Funding requested from HPRC members.

November 2014
HPRC members approve final support for execution. Project funding activated. Develop intro letters, overviews, and presentation materials. Chicago chosen as target market.

December 2014
Initial meetings with UCMed and Northshore. Rob Render on board. Recycler RFP goes out.

2015

January 2015
Recycler RFP proposals due.

February 2015
Begin hospital training material development (poster, ppt.).

March 2015
Ravago interested in partnership.

April 2015
Northwestern Memorial out due to Stericycle conflict. Cardinal Health out due to contamination concerns.

May 2015
Erika Kimball RN on board.

June 2015
Lakeshore and WM on board. Northshore, Alexian, and Advocate hospitals move forward with pilot.

July 2015
Key Green on board. Baseline recycling questionnaire finalized and sent to hospitals. First round of material samples delivered to WM.

August 2015
Bag design finalized.

October 2015
Three month commitment from Antek

November 2015
Initiate tracking and metrics conversations with all participants. East Terra out due to market fluctuation.

December 2015
Collection begins at Northshore. Delays with Lakeshore collection due to issues with their facility.

2016

February 2016
Collection begins at Advocate. Bags go into production.

March 2016
Project press release goes out. Recycling Today covers the project.

April 2016
Training materials now updated each round of visits to reflect the training gaps discovered. Renewed interest from Presence Health. Feedback provided to hospitals

May 2016
Antek Madison reports quality issues with the materials they are receiving.

June 2016
Initiative begins to get baseline metrics from waste haulers and hospitals. Also evaluating other channels that may provide metrics baselines and insights.

July 2016
Timeline creation and initial project output and promotion planning discussions begin. Initial collection of lessons learned and insights begins.

Appendix B – Materials Process Flow

Materials Process Flow

Materials Accumulation:
- Segregated bags/color coded
- Department-specific process
- Pre-case/pre-incision

Materials Transfer:
- To department accumulation area (or)
- To dock area

Single Stream Recyclables Path

Load to comingle compactor

Transport to MRF/ Transfer Station

Segregate bags from other recyclables

Load to transport vehicle

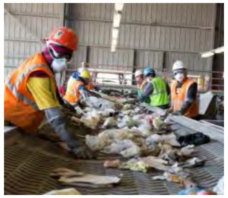
Transport to Recycler

Reverse Distribution Path

Load to pallet cage

Transport to Recycler

Recycler sorts by form and/or resin type



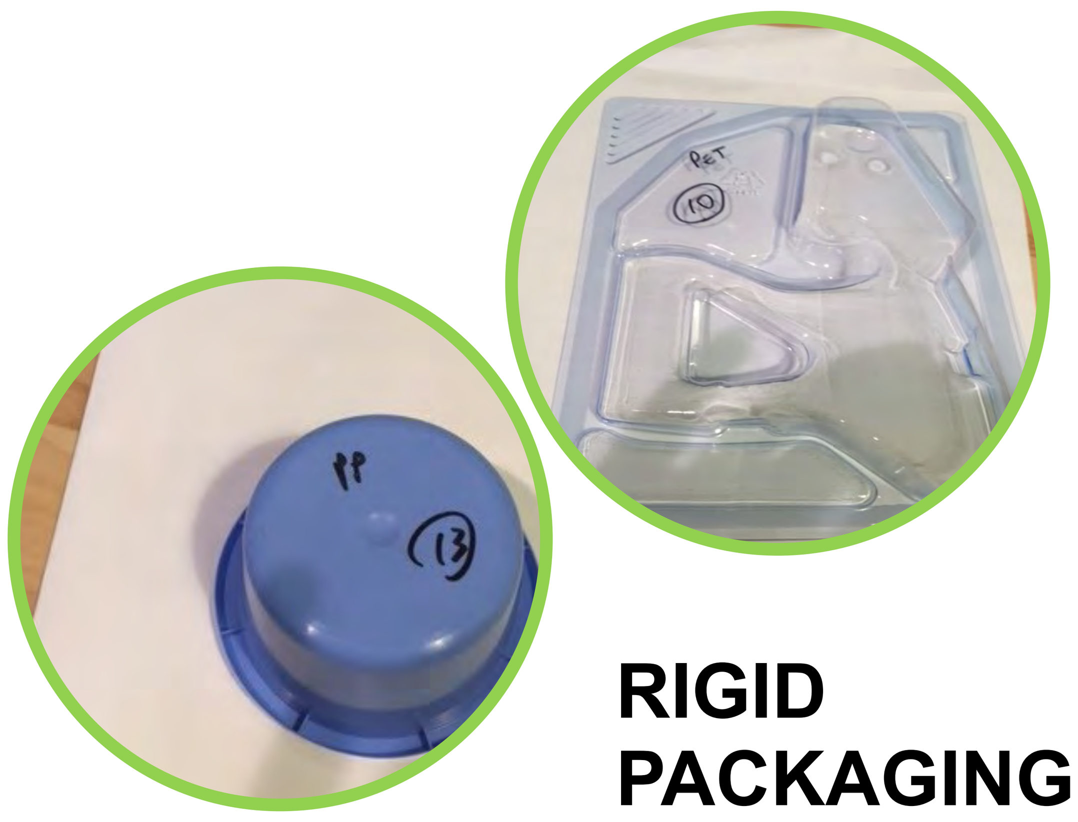
Bale/process for sale to reclaimer/compounder

Appendix C – Poster Template

Main OR Clinical Recycling Guide

RECYCLE

the following items



RIGID PACKAGING

TYVEK®

Sterile barrier packaging, peel pouch and rigid tray lids

Tyvek® looks like paper but does NOT tear!

BLUE WRAP

Clean blue sterilization wrap, and drape/gown overwrap

CONTAINERS

Irrigation bottles, empty sani-wipes

PLACE ITEMS IN HAZY BAGS WITH GREEN PRINT

TRAYS & PITCHERS

DO NOT RECYCLE

the following items

Consult EVS with any questions regarding disposal

METALLIC MATERIALS

Foil backed packaging, equipment with metal screws

RMW, SHARPS

FLEXIBLE PACKAGING

Plastic film from sterile packs, supply sleeves, syringe & IV packaging

PEEL PACK

CLEANING, PREP, PPE

Foam, paper towels, cotton materials, gloves, gowns, masks, foot & head covers, bunny suits

USED MEDICAL SUPPLIES

Rubber items, hose, wire, paper, IV bags

TIPS FOR SUCCESS

Clean, dry, clinical materials only.
Separate rigid peel-packs completely.
SAFETY FIRST: When in doubt, throw it out!

QUESTIONS?

Katie Wickman
katie.wickman@advocatehealth.com

HPRC Healthcare Plastics Recycling Council

spi the plastics industry trade association

Advocate Illinois Masonic Medical Center

Appendix D – Technical Analysis of Blue Wrap

RÉQUISITION D'ANALYSE REQ

REQ #	GL148-61	**Programme injection:**
GL #	148	MÉMOIRE #24: PP SUNOCO MOULE 60°C POUR LES TIGES DE TRACTION, FLEXION, IMPACT, HDT
Demandeur	Doru	MÉMOIRE #20: PP Deform Eject MOULE 45C +/- 5 Dosage de 19 mm POUR DÉFORMATION D'EJECTEURS
Date de demande	19.11.2015	**Autres conditions:** SÉCHER POUR AVOIR MOINS DE 200PPM À 60°C si nécessaire
Materiel	MPE-PPHOSP-MP2	
Localisation	ENTRE RACKS RDLPC	

Nbre tests externes	Descripteur	Conditions du test	Méthode ASTM/ISO	Unité					MPE-PPHOSP-MP2				
	Densité		ASTM -D792	X				X	0.910				
	Melt flow index	2.16Kg / 230 °C	ASTM-D1238 mét. A	X	g/10min			X	72.5				
	Humidité	RÉCEPTION	ASTM-D6869	X	ppm			X	33.01				
	Humidité	AVANT INJECTION	ASTM-D6869	X	ppm			X	33.01				
	Humidité	AVANT VISCOSITÉ OU MELT	ASTM-D6869	X	ppm			X					
	Contenu en charge		ASTM-D2584 et D5630	X	%			X	0.3846				
	DSC melt et crystalisation	Tm: Temp. Melt	ASTM-D3418	X	°C		°F	X	163.63				
		Hm: Delta H melt	ASTM-D3418	X	J/g			X	122				
		Tcc: Temp. Cryst. Cooling	ASTM-D3418	X	°C		°F	X	122.63				
		Hcc: Delta H Cryst. Cooling	ASTM-D3418	X	J/g			X	118.6				
	IZOD à 23°C	NOTCHED RAYON D'ENTAILLE: 0.25 mm	ASTM-D256	X	pi*Lb/po		J/m	X	0.45				
	Résistance en traction: max charge	50 mm/min	ASTM-D638		psi	X	Mpa	X	35.6				
	Module en traction	50 mm/min	ASTM-D638		psi	X	Mpa	X	1873				
	Élongation en traction: rupture	50 mm/min	ASTM-D638	X	%			X	6.15				
	Résistance en flexion	1.3 mm/min	ASTM-D790		psi	X	Mpa	X	52.8				
	Module en flexion	1.3 mm/min	ASTM-D790		psi	X	Mpa	X	1739				
	HDT 455 Kpa		ASTM-D648	X	°C		°F	X	107				
	Identification FTIR		IT_L.74	X				X	PP				
	Identification FTIR % DE MATCH		IT_L.74	X	%			X	98.92				
	Délamination		IT_L.32	X				X	OK				
	Dégradation thermique	5 minutes	IT_L.35	X				X	A				
	DÉFORMATION DÉJECTEUR	MÉMOIRE 20 dosage19 mm moule 45C +/-5	L-68	X	mm			X	0.100				
1	DIGESTION	Ca , Mg, Fe, Zn, Pb	EXTERNE ICP-MS	X	ppm			X					
1	EDS		EXTERNE ToF	X	ppm			X					
	GDS		EXTERNE ToF	X	ppm			X					
	Total EDS GDS		EXTERNE ToF	X	ppm			X					
2	Total heures technicien						Technicien						
Total tests externe	Commentaires:												

MPE-PPHOSP-MP2		**Revue de contrat** Section reservée à la Direction du Laboratoire
0		Essai accepté Approuvé par
0		Date de rapport
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Générales		

Appendix **E** – Principles of 5S

What is 5S?

One of the methods of determining an organizations approach to its business is to evaluate its workplace organization capability & visual management standards.

5S engages people through the use of 'Standards' and 'Discipline'.

It is not just about housekeeping, but concentrating on maintaining the standards & discipline to manage the organization - all achieved by upholding & showing respect for the Gemba [workplace] every day.

The 5 Steps are as follows:

Sort: Sort out & separate that which is needed & not needed in the area.

Straighten: Arrange items that are needed so that they are ready & easy to use. Clearly identify locations for all items so that anyone can find them & return them once the task is completed.

Shine: Clean the workplace & equipment on a regular basis in order to maintain standards & identify defects.

Standardize: Revisit the first three of the 5S on a frequent basis and confirm the condition of the Gemba using standard procedures.

Sustain: Keep to the rules to maintain the standard & continue to improve every day.

Benefits of 5S Workplace Organization

5S relates to workplace organization and forms a solid foundation upon which many organizations base their drive for continuous improvement. It is equally applicable & successful in all sectors helping to achieve high impact results.

It is a systematic and methodical approach allowing teams to organize their workplace in the safest and most efficient manner.

The discipline to check & repair equipment is included & adopted. The entire process is managed through the use of team generated audit documents, completed on an agreed frequency by responsible owners within the Gemba.

Summary

- Improved safety
- 5S becomes a fundamental business measure & key driver for Kaizen
- Forms a solid foundation upon which to build continuous improvement
- Employees gain a sense of ownership, involvement & responsibility
- Reduction in waste – as defined by Ohno's seven forms of waste
- Improved performance in productivity, quality & morale leads to increased profitability

https://www.kaizen.com/knowledge-center/what-is-5s.html

Appendix F – Circular Economy Perspective

FIGURE 1: OUTLINE OF A CIRCULAR ECONOMY

PRINCIPLE
1

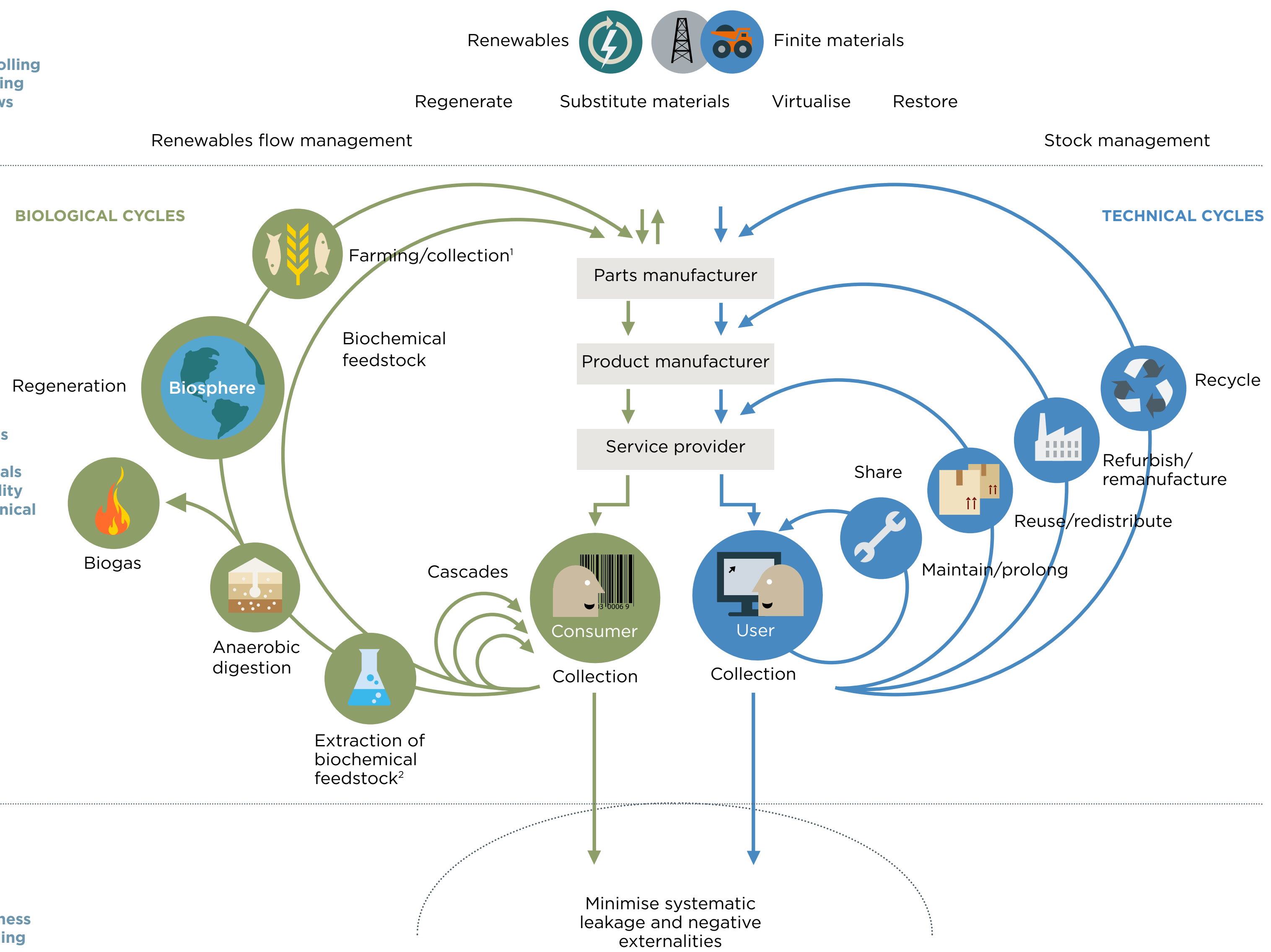
Preserve and enhance natural capital by controlling finite stocks and balancing renewable resource flows

PRINCIPLE
2

Optimise resource yields by circulating products, components and materials in use at the highest utility at all times in both technical and biological cycles

PRINCIPLE
3

Foster system effectiveness by revealing and designing out negative externalities



1. Hunting and fishing
2. Can take both post-harvest and post-consumer waste as an input

Source: Ellen MacArthur Foundation and McKinsey Center for Business and Environment; Adapted from Braungart & McDonough, Cradle to Cradle (C2C).